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MAR 79 T E BROWN, W S MYLES, C L ALLEN

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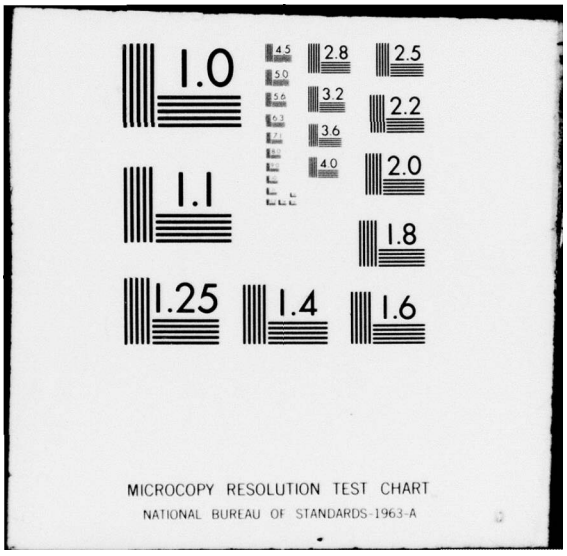
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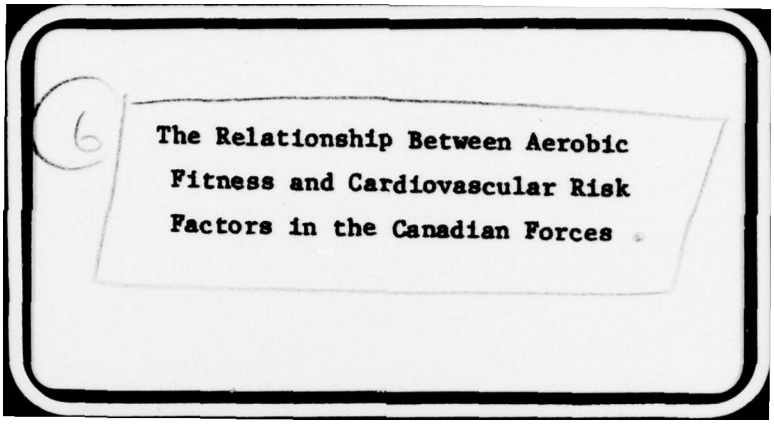
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The Relationship Between Aerobic
Fitness and Cardiovascular Risk
Factors in the Canadian Forces

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DEPARTMENT OF NATIONAL DEFENCE - CANADA

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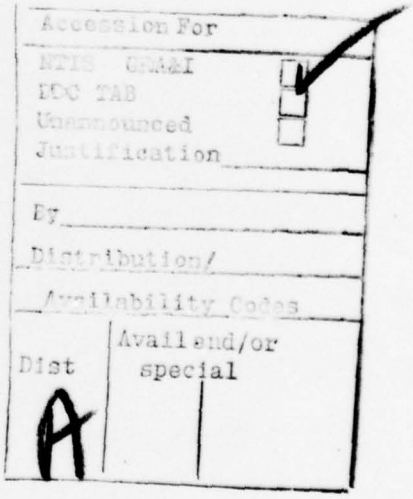

ABSTRACT

Aerobic fitness and the incidence of risk factors related to cardiovascular disease (CVD) were compared for 1595 Canadian servicemen 20-50 years of age. Aerobic power ($\dot{V}O_2$ max) was predicted from heart rates during submaximal exercise performed on a bicycle ergometer. The risk factors, body fat, serum cholesterol, serum triglycerides and blood pressure were measured by standard procedures. Smoking histories were obtained by questionnaire. A positive relationship was demonstrated between $\dot{V}O_2$ max and all of the CVD risk factors examined. This relationship was most significant among those over 40 years of age, the age group most at risk from CVD. The validity of this and other studies relating aerobic fitness to susceptibility to CVD is discussed.

INTRODUCTION

The Canadian Forces (CF) has invested a significant amount of time and money in the training of personnel by the time they reach middle age. At a time of life when most men are expected to be at their most productive, cardiovascular disease (CVD) is epidemic and is the single largest cause of death among middle-aged men. In an attempt to understand the causes of the disease, research has identified certain risk factors which predispose individuals to CVD (9,10,15). Many risk factors, such as cigarette smoking, hypertension or hypercholesterolaemia, reflect a way of life and this raises the possibility that susceptibility to CVD could be reduced in the CF by modifying lifestyle.

This report documents the relationship between physical fitness (aerobic power) and selected cardiovascular risk factors in a representative sample of the CF population.

METHODS

Fifteen hundred and ninety-five male military personnel located at six CF bases across Canada were tested for aerobic fitness and evaluated for selected cardiovascular risk factors.

Aerobic Fitness

Aerobic power ($\dot{V}O_2$ max) was predicted from a submaximal exercise test using the MONARK bicycle ergometer. The total work period lasted nine minutes at a pedalling speed of 50 rpm. The first and second three minute workloads were 450 and 750 kgm/min, respectively. Heart rate during the last 15 seconds of each stage was measured using a CAMBRIDGE electrocardiograph. Based on the subject's performance during the first two stages, a workload was selected which would produce a heart rate of 140-150 bpm during the final three minutes. The heart rate during the last 15 seconds of the last workload was used to predict $\dot{V}O_2$ max according to the nomogram of Astrand and Ryhming (2). Individuals were classified into one of four categories of $\dot{V}O_2$ max (Figure 1) as adopted from the standards of Cooper (3) and incorporating the Astrand age correction (1).

Body Fat

The degree of body fatness was determined by measuring three skinfold thicknesses (at triceps, subscapular and suprailiac sites) using HARPENDEN calipers. Individuals having a skinfold

thickness (sum of the three sites) exceeding 50 mm were considered to have excess fat.

Blood Lipids

Morning blood samples were collected by venipuncture from subjects who had fasted for 12-14 hours. Cholesterol and triglyceride concentrations were assayed by standard clinical techniques. Within this report, the criteria for hyperlipidemia are values greater than 279 mg/dl for cholesterol and 200 mg/dl for triglyceride.

Blood Pressure

Systolic and diastolic blood pressures were measured with the subject seated at rest in a chair. Within this report, the criteria for hypertension are values greater than 140 mm/Hg systolic and 90 mm/Hg diastolic.

Smoking History

Those who smoked cigarettes were identified from their personal history questionnaires. Those who failed to complete the questionnaire, pipe smokers and cigar smokers, were excluded from the data analysis. No attempt was made to record other pertinent information such as the quantity of cigarettes smoked, the length of time since starting the habit or whether nonsmokers had ever smoked.

Statistics

The total population tested was divided into three age groups and each of these was subdivided by assigning the personnel to one of four fitness categories (Table 1). The relationships between risk factors and fitness were examined by subjecting the data to two-way analysis of variance. The Duncan multiple range test was used to determine the significance of differences between means due to fitness or age.

RESULTS

The distribution of the 1595 subjects into age groups and fitness categories (Table 1) shows that the number of men in each group was not markedly different and that the majority in each age group were in the fair or good fitness category. As age increased, the proportion of men categorized as excellent declined and the proportion categorized as poor increased.

Tables 2-5 show the mean values for body fat (skinfold thickness), serum cholesterol, serum triglycerides and blood pressure for the three age groups divided into the four fitness categories. Also included are the percent of subjects in each fitness category with too much body fat, elevated cholesterol, elevated triglycerides and high blood pressure according to the criteria outlined in the methods section. Both the mean value and the percentage of individuals with high values tended to be lower in the superior fitness categories. This effect was most marked for body fat and serum cholesterol (Tables 3 and 4) and was less pronounced for serum triglycerides and blood pressure (Tables 4 and 5).

Table 6 shows the percentage of subjects in each fitness category who smoked cigarettes. Although there was no relationship between the smoking habit and VO_2 max for individuals under 30 years of age, the incidence of cigarette smoking was markedly lower in the excellent fitness category for the two older age groups.

Statistical analysis of the data confirmed that the relationship between the CVD risk factors and fitness was most significant when the categories poor and excellent were compared to each other and was most significant for the over 40 age group.

DISCUSSION

A positive relationship appears to exist between aerobic fitness and the incidence of certain CVD risk factors in a representative sample of the Canadian military population. Furthermore, this relationship was most marked in males over 40 years of age, the group who are most at risk from CVD. A similar conclusion was drawn from the results of a survey of 3000 male civilians in the United States (4). Since both were cross-sectional studies, neither was able to establish cause and effect.

Other cross-sectional studies attempting to relate recreational (5,12) and occupational (11,13) activity levels to mortality from CVD have been criticized because the measurements of fitness were imprecise and qualitative. This criticism cannot be levelled at the present investigation since VO_2 max was determined on all subjects by an accepted laboratory procedure (2,7). In addition, body fat, serum lipids and blood pressure were directly measured, the incidence of cigarette smoking being the only data collected by questionnaire.

To establish cause and effect requires a longitudinal study,

one in which fitness and risk factors are measured before and after a period of training. Even those longitudinal studies (6,8, 14,16) in which changes in fitness and risk factors were solidly documented have not unequivocally established the benefits of improved aerobic fitness.

While the evidence provided by this and other studies is not conclusive, it does suggest that the incidence of CVD risk factors can be reduced by improving aerobic fitness. If this is true, the implications for the CF are significant. Reducing susceptibility to CVD is a strong rationale for encouraging a high level of fitness in all personnel.

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TABLE 1

Distribution of Subjects into Categories of Aerobic Fitness and Age Groups

Age (years)	Fitness Category				Fitness Category Categories Combined
	Poor	Fair	Good	Excellent	
less than 30	50 (10.5)	134 (28.0)	177 (37.0)	117 (24.5)	478 (100)
30-39	88 (16.8)	222 (42.5)	145 (27.7)	68 (13.0)	523 (100)
more than 40	139 (23.4)	237 (39.9)	145 (24.4)	73 (12.3)	594 (100)

Values are numbers of subjects. Percentage in each fitness category is shown in parentheses.

TABLE 2

Distribution of Mean Body Fat (Sum of 3 Skinfolds) into Categories of Aerobic Fitness and Age Groups

Age (years)		Fitness Category			
		Poor	Fair	Good	Excellent
less than 30	n	50	134	177	117
	$\bar{x}$	66.2±2.5	51.9±1.7	41.6±1.2	33.5±1.2
	%	81.3	45.1	23.6	10.3
30–39	n	88	222	145	68
	$\bar{x}$	65.1±2.0	54.4±1.2	46.5±1.3	41.8±1.7
	%	77.5	58.6	40.1	27.9
more than 40	n	139	237	145	73
	$\bar{x}$	60.3±1.5	54.5±1.1	48.3±1.1	44.1±1.7
	%	68.3	60.1	40.0	38.2

Values shown are the number of subjects (n), the mean ± SEM ($\bar{x}$) and the percentage with a skinfold thickness, sum of three sites, in excess of 50 mm (%).

TABLE 3

Distribution of Mean Serum Cholesterol into Categories

of Aerobic Fitness and Age Groups

Age (years)		Fitness Category			
		Poor	Fair	Good	Excellent
less than 30	n	40	95	144	102
	$\bar{x}$	202.8±5.8	195.3±4.0	185.7±3.2	177.1±3.3
	%	2.5	0	1.4	1.0
30-39	n	76	179	122	53
	$\bar{x}$	230.1±5.4	217.5±3.9	203.9±3.5	208.0±5.6
	%	14.5	10.6	4.1	5.7
more than 40	n	123	212	131	68
	$\bar{x}$	237.5±4.1	231.0±2.7	229.4±3.5	214.4±4.6
	%	19.5	11.3	12.2	5.9

Values shown are the number of subjects (n), the mean ± SEM ($\bar{x}$) and the percentage with a cholesterol above 279 mg/dl (%).

TABLE 4

Distribution of Mean Serum Triglyceride into Categories

of Aerobic Fitness and Age Groups

Age (years)		Fitness Category			
		Poor	Fair	Good	Excellent
less than 30	n	15	41	22	14
	x	97.2±10.0	120.2±9.9	90.5±5.7	98.3±13.3
	%	0	9.8	0	7.1
30-39	n	41	61	43	20
	x	174.2±13.4	153.6±16.9	133.9±9.0	108.3±13.5
	%	31.7	19.7	11.6	5.0
more than 40	n	94	134	82	35
	x	166.0±10.2	156.2±7.3	137.8±7.4	100.5±6.7
	%	27.7	20.9	13.4	2.9

Values shown are the number of subjects (n), the mean ± SEM (x) and the percentage with a triglyceride above 200 mg/dl (%).

TABLE 5

Distribution of Mean Blood Pressures into Categories

of Aerobic Fitness and Age Groups

Age (years)		Fitness Category			
		Poor	Fair	Good	Excellent
less than 30	n	47	129	163	107
	SBP	127.7±1.7	124.4±1.1	119.6±0.9	118.8±1.1
	DBP	77.7±1.2	73.0±0.7	71.8±0.7	69.1±0.9
	%	10.6	7.8	3.7	5.6
30-39	n	87	202	130	61
	SBP	128.7±1.4	124.2±1.1	121.2±1.0	122.1±1.6
	DBP	80.3±1.0	77.9±0.7	75.3±0.8	76.3±1.4
	%	20.7	11.4	6.9	11.5
more than 40	n	131	195	123	65
	SBP	128.7±1.2	122.6±0.9	126.2±1.1	121.0±1.3
	DBP	81.9±0.7	79.5±0.6	79.9±0.8	76.8±1.0
	%	21.4	9.7	18.7	1.5

Values shown are the number of subjects (n), the mean ± SEM for the systolic blood pressure (SBP), either the diastolic blood pressure (DBP) and the percentage with either a systolic above 140 mm/Hg, a diastolic above 90 mm/Hg, or both (%).

TABLE 6

Distribution of Smokers into Categories of Aerobic Fitness and Age Groups

Age (years)		Fitness Category				Total for All Fitness Categories
		Poor	Fair	Good	Excellent	
less than 30	n	45	125	169	110	449
	% smokers	53	54	50	66	55
30-39	n	84	206	138	59	487
	% smokers	66	52	45	24	49
more than 40	n	125	200	113	66	504
	% smokers	49	49	46	21	44

Values shown are the number of subjects (n) and the percentage who were smokers.

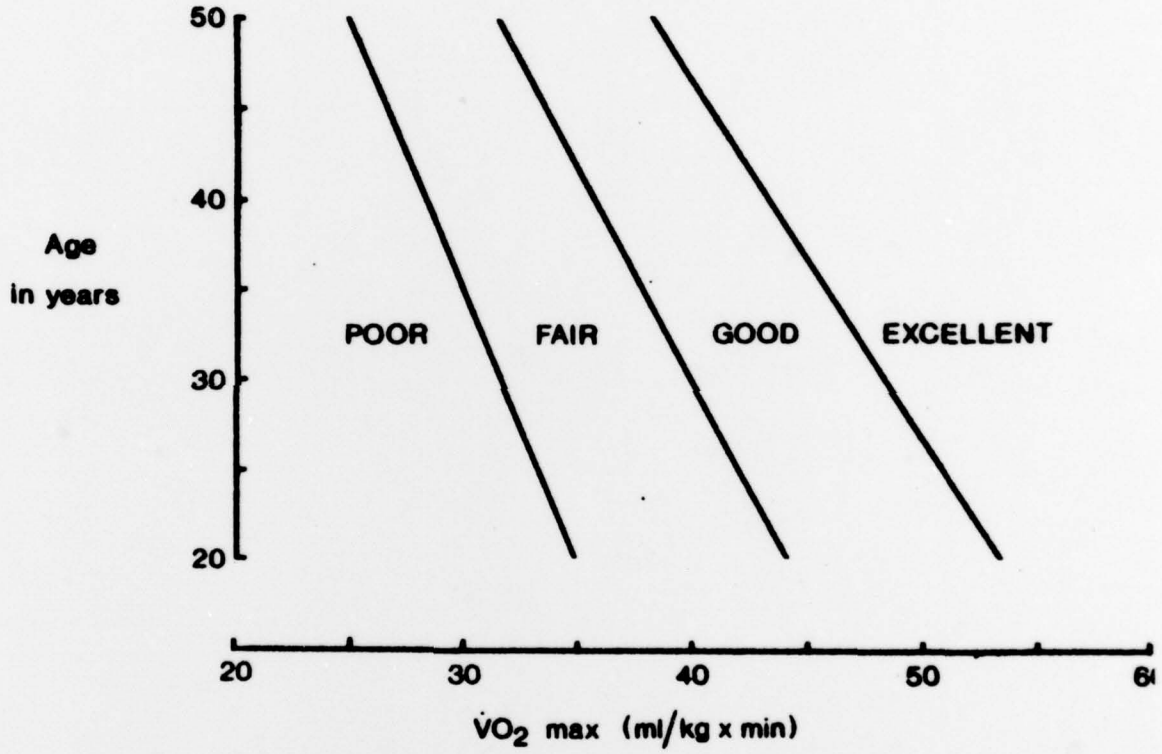

Figure 1: Categories of $\dot{V}O_2$ max for men, based on the standards of Cooper (1968) and incorporating the Åstrand (1960) age correction.

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